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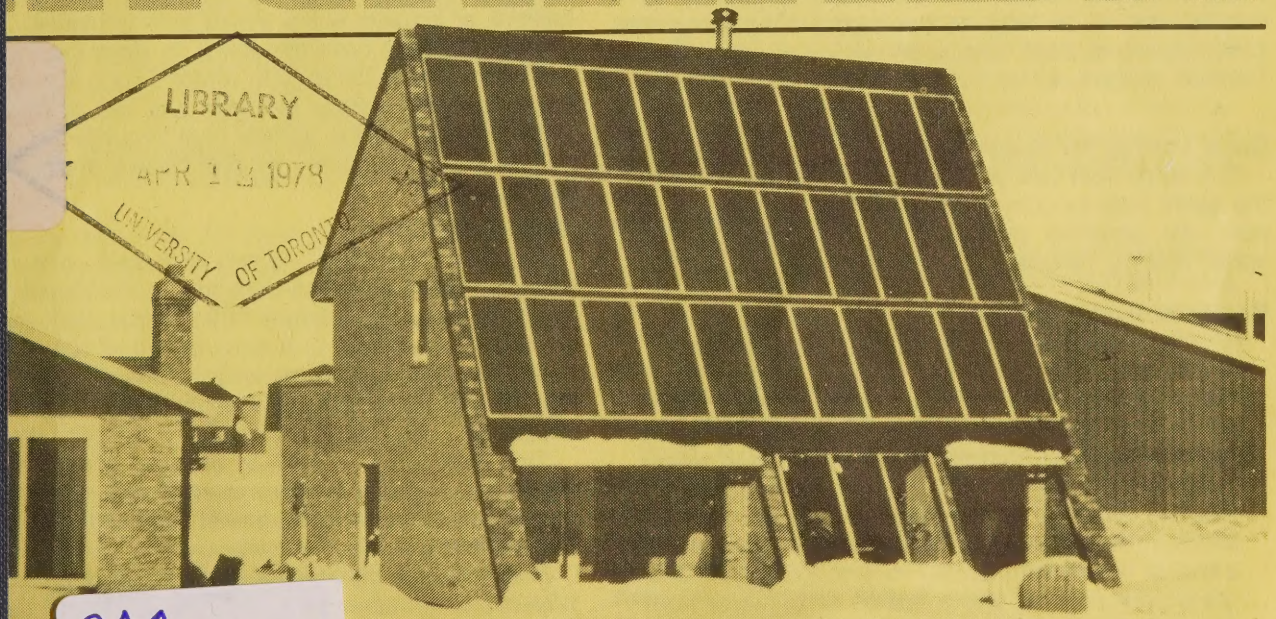
SOLAR HEATING IN CANADA



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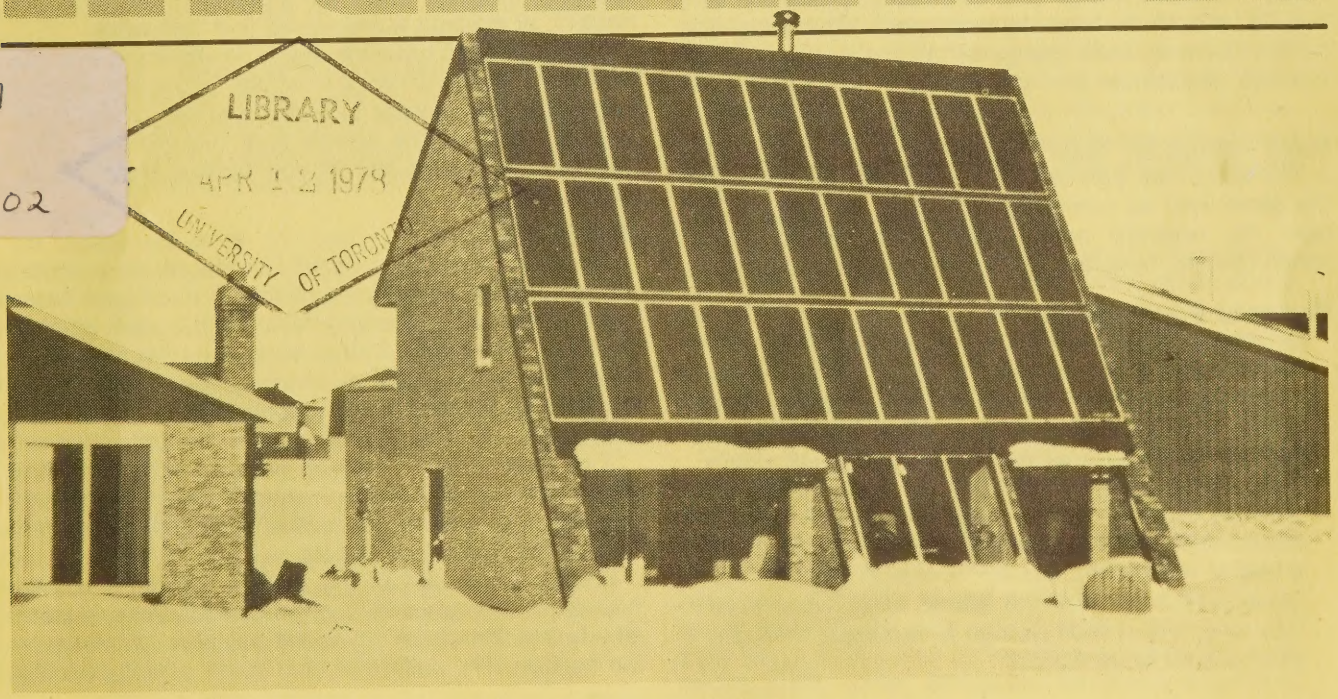

The sun is the most important source of energy available to man. Without it, life on earth would be impossible. But we needn't worry. We know that the sun will continue to heat the earth for billions of years to come. However, this is not true of our fossil fuels, such as oil and gas, which may very well become depleted within two or three generations.

Since fossil fuels are the backbone of economic activity in Canada, the problem is serious indeed. Oil, gas, and coal serve to run our factories, to produce electricity, to move our trucks, buses, and trains, and to heat our homes, buildings and offices. Heating alone uses 31.5% of our total energy consumption. It becomes imperative to find other ways of keeping ourselves warm in the cold Canadian climate.

One way would be to use solar energy. It can be used to heat buildings, and could help conserve our oil for vital transportation, for which substitute fuels are difficult to find.

However, we just cannot switch overnight to solar heating. Although we could in principle extract from the sun all the energy that we need, the cost of doing so is prohibitive.

But since the sudden rise in oil prices in 1973, the comparative cost of solar heating has moved very close to that of conventional ways of heating space and water. In Canada, this new interest in solar energy is reflected in the annual doubling of federal funds earmarked for solar research in the last three years. For 1978-79, this will amount to almost $8 million, or 5.3% of the total federal expenditures on research and development in energy.

Technological advances and mass production are expected to further reduce the cost gap between solar heating and oil and gas heating.

By the year 2000, experts estimate that solar heating could contribute as much as five per cent of our total energy supply. There are many solar systems to choose from, and some are available commercially today. However, there are still many problems to resolve, not all of them technological. One thing is certain however, solar energy can definitely be used in Canada, despite our cold climate.

Solar Energy for Space Heating

The sun's heat can be used to heat homes in much the same way as conventional heating systems do it now. An essential prerequisite for economic solar space heating, however, is a well insulated structure.

Basics of Solar Heating

In general, solar heating consists of several steps:

**Collecting the heat:* with a bank of dark, heat absorbing panels or collectors designed and oriented to trap solar energy and often located on a rooftop. The heat is carried by a fluid such as water, glycol or air circulated through the collectors;

**Storing the heat:* heated water can be stored in an insulated tank while heated air can be transferred to a bed of rocks, both usually located in a basement;

**Distributing the heat:* the heated air or water from the collectors or heat storage is circulated throughout the area to be heated;

**Controlling the system:* pumps, valves and automatic controls are used to collect and distribute the solar heat;

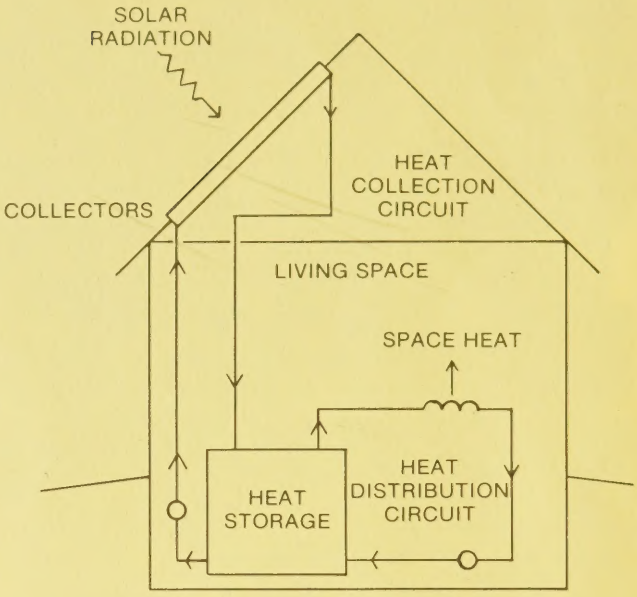

Figure 1. Components of a solar heating system.

Most of the components of a solar-heating system, except the collectors and storage equipment, are standard heating and plumbing items.

At present, most solar heating systems are not designed to supply all the heat an individual home will need. A system designed to provide about 50 per cent of the annual heat requirements is generally accepted as the most feasible. In December and January, for these systems, solar energy is unable to provide all the home heating, but by the end of March almost all the heating requirements can be furnished by the sun. Such systems are supplemented by conventional auxiliary systems such as electricity, oil and gas heaters, or efficient wood stoves and fireplaces.

Other systems have the ability to store the summer solar heat and to deliver it in winter. These are referred to as "seasonal storage systems" and can, in principle, provide 100% of the annual heat requirement. They appear to be best suited for row houses and multiple-unit buildings.

Solar Collectors

The solar collectors, usually mounted on a south-facing rooftop, are equivalent to the traditional basement furnace. As sunlight falls on the dark-painted absorber (see Figure 2) it is trapped and converted to heat. The use of glass or plastic covers prevents the loss of heat by acting as a miniature greenhouse over the panels.

The heat-carrying fluid is pumped through pipes within the collector and is heated. This solar heat can then be used immediately to heat the building or stored for use during sunless periods.

Proper orientation of the collector is necessary to take maximum advantage of the sun's energy, especially during the winter when the sun is much closer to the horizon. The collectors face south, and depending

on the latitude, are tilted upwards. In the Ottawa area, the optimum tilt angle is about 60° from the horizontal, but variations can be tolerated without seriously affecting performance.

Maximum temperatures achieved by flat-plate collectors can range from 65°C to 90°C. Newer models using vacuum-type or parabolic concentrator collectors, in conjunction with specially-coated piping, can operate at temperatures of up to 175°C. These newer models, however, are still in prototype stage and expensive.

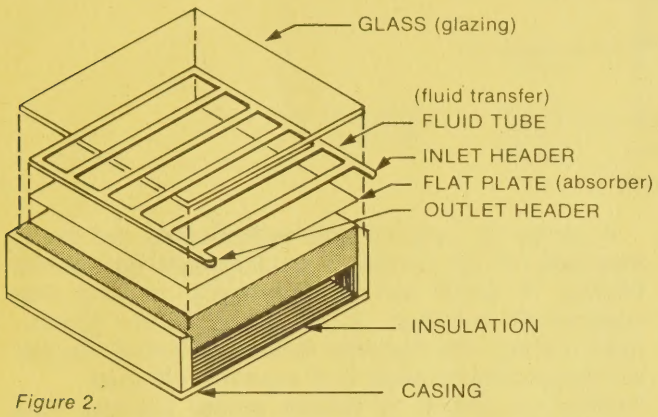

Figure 2.

Solar Space Heating Systems

Two kinds of solar heating systems have become popular:

— one uses water or antifreeze solutions flowing in pipes as the heat transfer medium, and stores heat in a large insulated tank, and

— the other circulates hot air in ducts with excess heat being stored in fist-sized rocks or gravel in a basement room or container.

Both systems have about the same efficiency and store enough heat for between 2 and 4 days. Air-based systems tend to be somewhat less expensive; they do not suffer from leakage or freezing, but require larger storage volumes than water-based systems.

Solar collectors using water or other liquids have to be protected from corrosion and freezing. The latter is done either by adding antifreeze or by a self-draining mechanism.

To supply about 50 per cent of the annual space heating requirements of a house, the collector area needed ranges from 25 to 50 per cent of the heated floor area. Thus, a typical, well-insulated home with a floor area of 140 square metres would probably require 35 to 70 square metres of collector area, or 10 to 20 solar panels, 1.2 by 3.0 metre size. Fewer panels would accordingly provide a lower solar proportion of total heating.

Estimates of the cost for installing a solar space heating system vary considerably. The total price, which can range between $5,000 and $15,000, would depend on the type of house, insulation quality, and the percentage of heating to be supplied by solar energy, and whether the system is fabricated on site by the building owner.

Passive Systems

The solar space heating systems described above are generally known as active systems, since they involve the *active* transportation by pumps or fans of a heat-carrying fluid through the collection and distribution stages.

Solar heating, however, can also be done *passively*, by carefully using such architectural features as south-facing windows, shutters, curtains, and walls. As a rule, these installations serve to maximize the collection and storage of solar heat, while minimizing heat losses. In some cases, they can play a dual role, such as an overhang above a south-facing window which allows the low winter sun in, while preventing the higher summer sun from overheating the house. The use of these features is generally referred to as a "passive system", and will undoubtedly become very important in the near future.

Solar Water Heating

Solar energy can also heat domestic water for showers, washing laundry and swimming pools. All that is needed is an unshaded area or south-facing roof with a minimum area of 6 square metres.

Unlike solar space heating, most solar water heating units are specifically designed to be added on to an existing house. Complete packages consisting of collectors, storage tank, pump, controls and pipe connections are available on the market. All the buyer has to do is attach the collectors on the roof and connect them to the storage tank. Costs can range from $1,000 for a kit to about $2,500 for the installed system.

The solar-heated water tank (see Figure 3) does not replace an existing tank, but is installed next to it. Instead of drawing water from the cold water inlet into the regular tank, water is drawn from the solar tank that has already been preheated by the sun. The solar water heating unit is in effect a *pre-heater*. On a sunny day in summer the water will be heated to 60°C or more so it may not even be necessary to heat it further in the regular tank. Even on a cloudy day in winter some heat will still be trapped from the sun, so that less energy will be needed to heat water than would normally be used.

Depending on the system size and water consumption, a solar water heater can provide between 65 and 80 per cent of the energy used to heat water during the year.

Swimming Pool Heating

Another use for solar heat that has become competitive is the heating of outdoor swimming pools during the summer. Such solar heaters often pay for themselves within a few years. Since pools are normally operated in the warmest months of the year, pool collectors rarely have to raise the water temperature more than 5-10°C.

South-facing panels are usually located on garage roofs, patio covers, open slope, or on a homemade or purchased rack. The collectors do not have to be tilted upwards as much as for heating a house and an angle of about 30 degrees from the horizontal appears adequate. The size of the collector area should be about one half the pool surface area. Costs can vary from about $2,000 and up for kits containing the solar panels, pipes, valves, fittings and temperature controls.

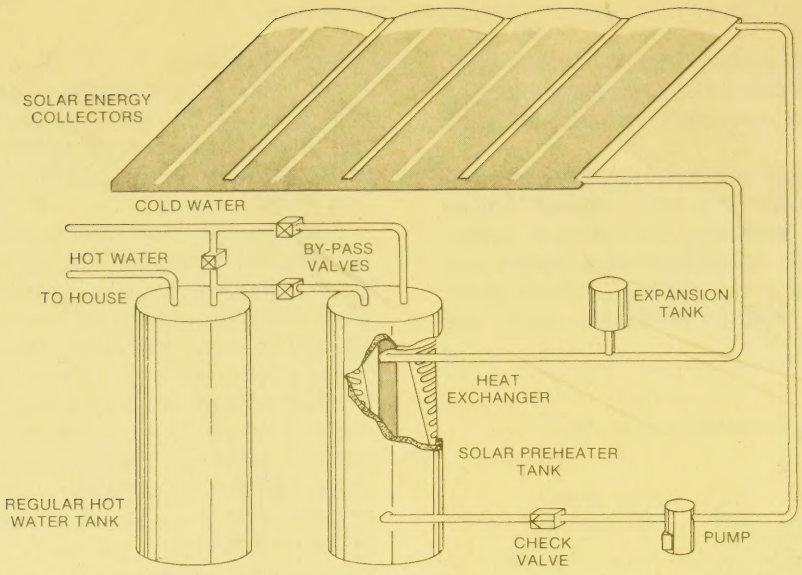

Figure 3. A four panel solar water heating package available commercially.

Some Issues Involved in Adopting Solar Energy

Solar radiation could make a significant contribution to Canada's future energy needs.

The majority of Canadians live in areas which receive sufficient direct sunlight and have a high enough heating demand to justify the application of solar energy to meet at least part, if not all, of their space and water heating requirements in residential and commercial buildings.

Currently, the major impediments to widespread use of solar space heating are the high capital costs of solar installations and lack of proven performance. Other difficulties facing the homeowner wishing to solar-heat their houses include the following:

i) absence of any legal guarantee that the sunlight will not be obstructed in the future by a neighboring structure,

ii) lack of consumer protection and long-term guarantees for most systems, and

iii) high capital costs of solar heating systems resulting in higher assessed values for houses and higher property taxes.

As of May 1976, the federal sales tax was removed from solar furnaces and solar collectors as part of the government's policy of providing encouragement for the use of energy conserving equipment. Some of the provinces have followed the federal government's initiative and have removed all or some of the sales tax on these and other related items. However, in order to protect the growing Canadian solar manufacturing industry, there is a twenty per cent import duty on all foreign solar equipment.

Government Programs

Officials in the new Renewable Energy Resources Branch of the Department of Energy, Mines and Resources are currently developing policies to encourage the application of solar technologies. They are studying the costs of solar energy, and are looking at its potential contribution to the Canadain energy budget, as well as the impact of a new Canadian solar manufacturing industry on the economy and the labour market.

A range of systems and technologies are being assessed across Canada, including total and partial heating in single and multiple-family housing and commercial buildings. In 1976, the federal government, through the National Research Council, funded the design and installation of experimental solar heating systems in 14 houses across Canada. This program was extended in the following year to cover multiple-unit housing projects and commercial buildings, schools and hospitals. Testing procedures, product quality standards and laws for the protection of the consumers are being examined by various federal and provincial government agencies.

Is Solar Heating Feasible in Canada

The two-hundred or so solar homes that have been built, or are still under construction in Canada, have demonstrated clearly that, although the principle of solar heating is simple, there are still a number of technical and institutional problems that have to be overcome before it becomes a viable alternative.

As more economical and reliable solar heating systems are developed it is expected that more and more Canadians will buy them to heat their homes and places of business. Although solar heating will not contribute more than a few per cent to our primary energy supply by the end of the century, its contribution in saving valuable liquid fossil fuels cannot be neglected. In the long-run, solar energy will provide a very definite relief and help stretch out the length of time these fuels will be available to run our cars and planes.

For more information on solar energy applications in Canada, write to Information EMR, Department of Energy, Mines and Resources, 588 Booth Street, Ottawa, Canada K1A 0E4.

Recent EMR renewable energy publications available:

* Catalogue of Solar Heating Products and Services in Canada
* Renewable Energy Resources: A Guide to the Literature
* Renewable Energy Resources: A Guide to the Bureaucracy